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Scintigraphical Examination of Inflammatory Joints in Arthritis

by

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Introduction

While radiographic changes are of limited value for clinical evaluation of arthritis at early stages, the use of radioisotope has been of significant value in diagnosing various arthritic conditions. External scintillation counting has been introduced as a sensitive method in detecting joint inflammation[2)3)]. Radioactive iodinated human serum albumin (^{131}I-HSA) and technetium ($^{99m}TcO_4^-$) have been used to measure the uptake of intravenously injected isotopes by the joint[1)2)3)4)6)]. Advantages of $^{99m}TcO_4^-$ over other isotopes are reproducibility for repeat measurement due to a short half-life, and absence of allergic reactions and side effects in the thyroid[1)]. This method reflected therapeutic responses of corticoid and chemotherapy[3)].

In the present report, technetium scintigraphy was made in arthritic patients for an objective evaluation of the progression of the arthritis. Therapeutic responses following gold therapy, radiation synovectomy and surgery were followed up in arthritic patients using technetium scintigraphy.

Methods

Fourty-five patients with various joint conditions (rheumatoid arthritis, 39; osteoarthritis, 4; systemic lupus erythematosus, 1; pigmented vilonodular synovitis, 1) were included in this study. Rheumatoid arthritis was defined according to the diagnostic criteria of the American Rheumatism Association[5)]. $^{99m}TcO_4^-$ was injected intravenously in a dose of 5 mCi. Radioactivity was recorded in chronological sequence for approximately one hour using a 2 x 2″ NaI (Tl) crystalline directed scintillation counter. As shown in Fig. 1, radioactivity in the affected joint increased immediately and reached a plateau 15 minutes following injection. Thirty minutes after injection, radioactivity of the joint was recorded using a pho/gamma III scintillation camera

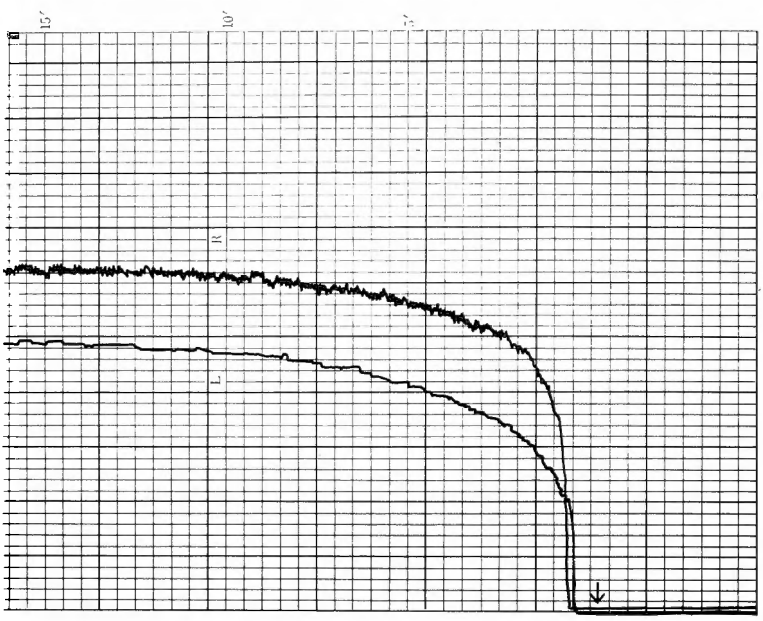
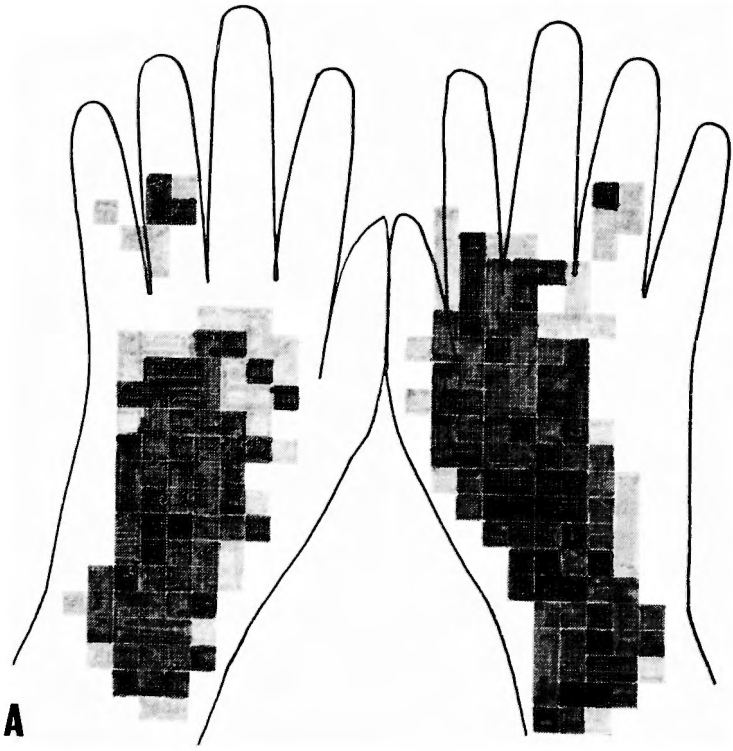


Fig. 1 Radioactivity of knee joint area was recorded using a crystalline directed scintillation counter. Increasing radioactivity on the affected side was more predominant.



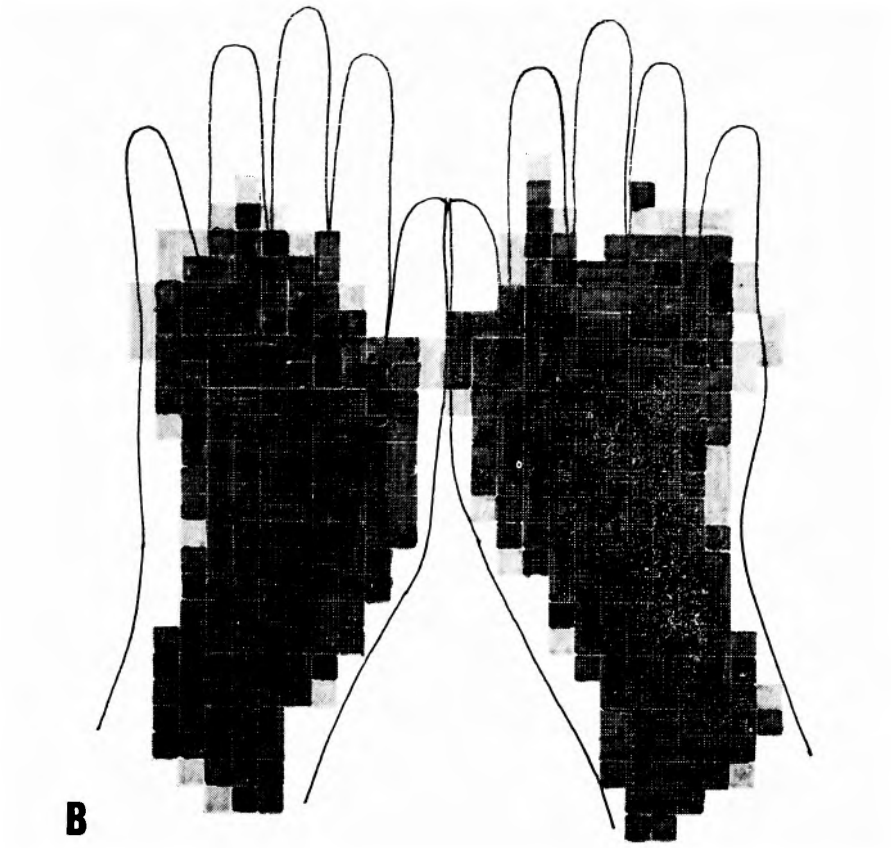


Fig. 2 Scintigram 15 minutes after radioisotope injection showed a very different pattern from that of 30 minutes after where radioactivity was markedly increased.

with a 4000 hole parallel collimeter and then was converted to signals X and Y axisis for digitalization by a pulse height analyzer with a 1600 channel core memory. As a control for activity in vascular bed and soft tissue, counts were obtained at skin contact over mid forearm or mid thigh. Scintigram was demonstrated in monochrom density gradient which was graded by digitalized value. The outline of joint can also be seen as it corresponded to the scintiphotograph. Antero-posterior and lateral projections were used for elbow, knee and ankle joints in scintigraphy. Scintigraphy were performed in the joint before and after therapy in order to assess therapeutic effects. Repeated scintigraphy, therefore, must be done under equal conditions such as same dose of injection and interval after intravenous injection of isotope. Although radioactivity of the joint was almost the same level after 15 minutes as shown in Fig. 1, scintigram of 15 minutes showed a very different pattern from that of 30 minutes as seen in Fig. 2.

Results

The following cases illustrate the pattern of loclization of increased radioactivity

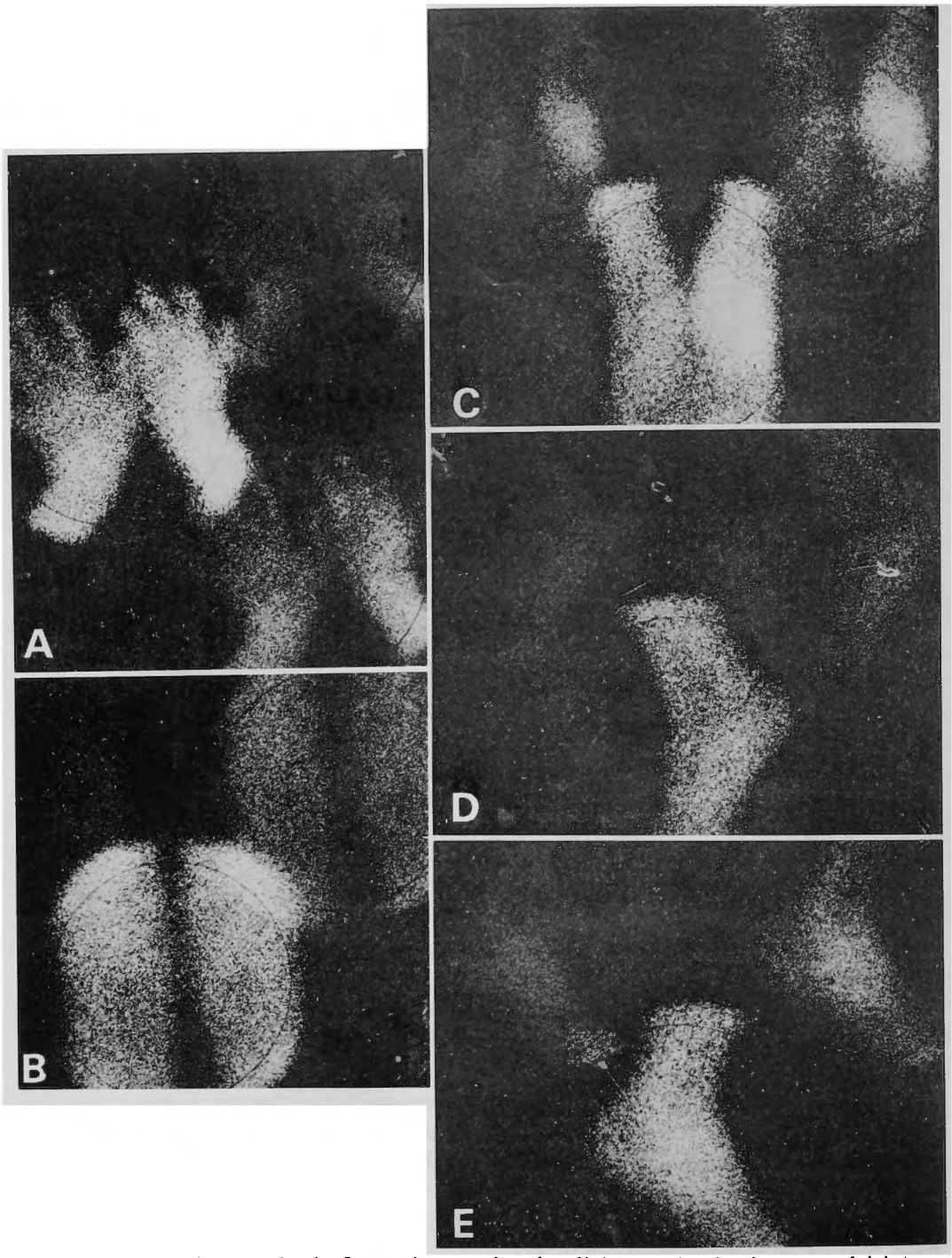


Fig. 3 Scintiphotograph. A : Increasing uptake of radioisotope in the intercarpal joint of left hand, and radiocarpal, intercarpal and carpometacarpal joints, MP joints of middle, ring and little fingers, and PIP joint of index finger of the right hand. B : No increasing radioactivity in knee joints. C, D and E : Note increasing radioactivity in left ankle joint in antero-posterior projection (C), where was confirmed to be Chopart and Lisfranc joints in lateral projection(D and E). (Case 1).

in scintigraphy.

Case 1. A 53-year-old female with definite rheumatoid arthritis, class 2, stage 2, had pain in both wrist joints, metacarpophalangeal (MP) joints of right middle and ring fingers, proximal interphalangeal (PIP) joint of right index finger and left ankle joint. Scintiphotograph showed same localization at the sites of complaints. It was clarified in lateral projection that increased radioactivity was not seen in talocrural or subtalar joint but in Chopart and Lisfranc joints (Fig. 3). Scintigram also showed the same pattern as the scintiphotograph yet was more distinct in the localization and intensity of increased radioactivity than the scintiphotograph (Fig. 4).

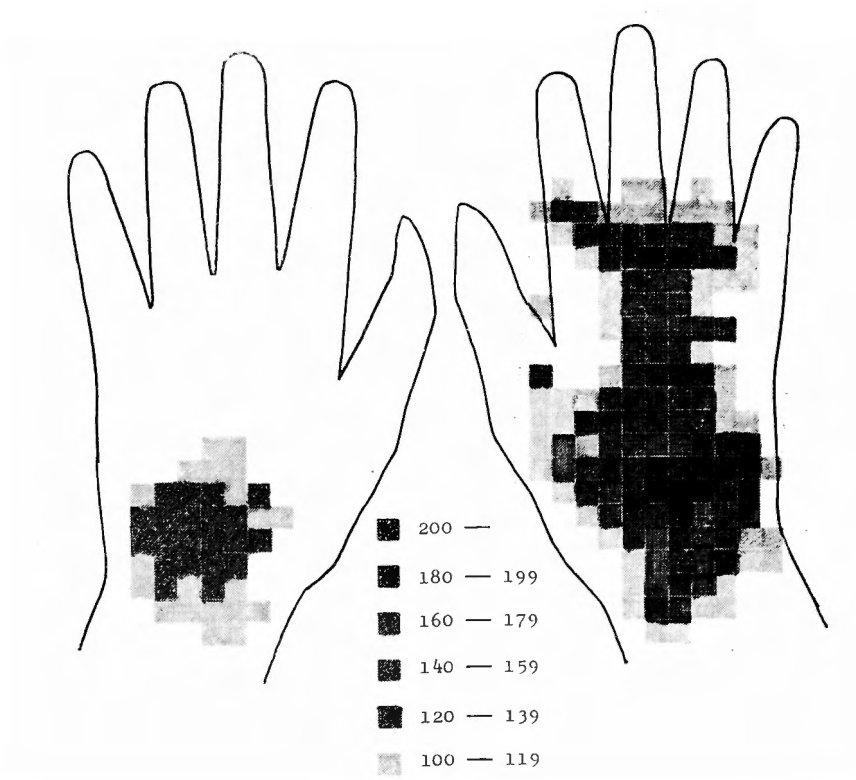


Fig. 4 Scintigram of both hands. Localization and intensity of uptake of isotope was more distinct in scintigram than in scintiphotograph.

Case 2. In a 62-year-old female with definite rheumatoid arthritis, class 1, stage 1, the scintigram showed positive localization in the left knee. Infrapatellar and posterior capsules were more positive than suprapatellar pouch (Fig. 5).

Case 3. A 64-year-old female was diagnosed as having osteoarthritis of the knee joints with persistent effusion. Scintigram did not reveal any increased radioactivity.

Case 4. A 42-year-old female with classical rheumatoid arthritis, class 1, stage 2, had complaints of swelling and pain of ankle joints and MP joint of left 2nd and 3rd toes. Scintigram showed talocrural, subtalar and Chopart joints of right foot, and

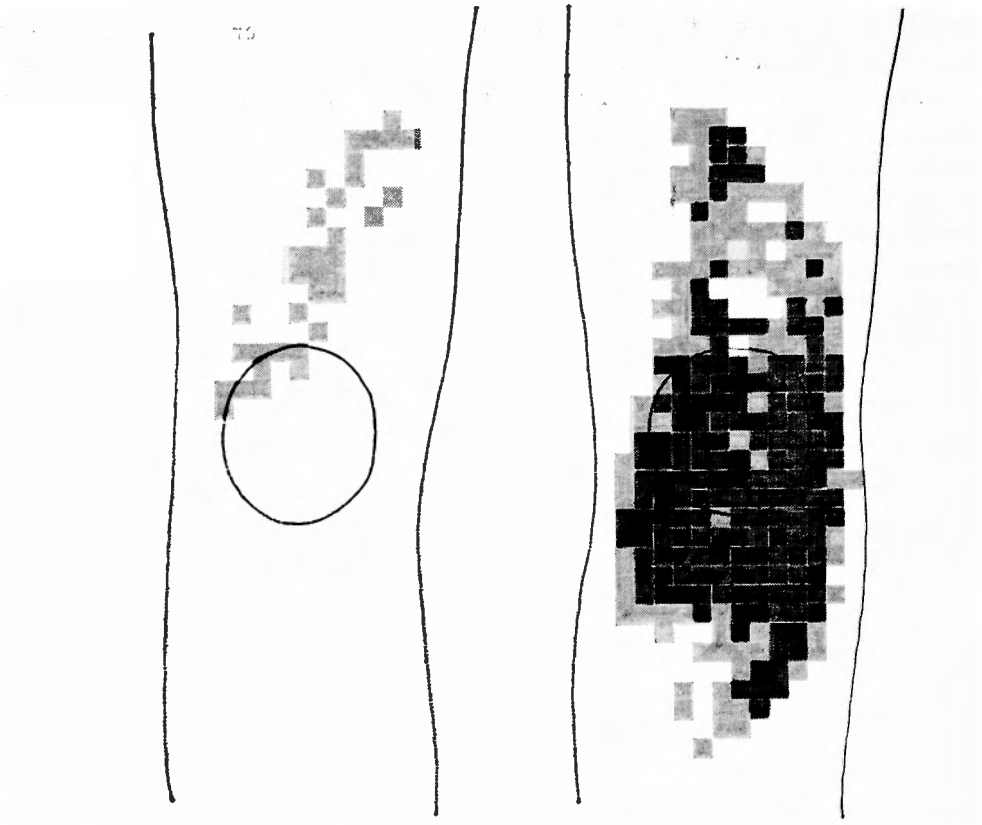


Fig. 5 Scintigram showed positive localization in left knee. (Case 2).

left Lisfranc joint and MP joint of left 2nd and 3rd toes (Fig. 6).

In the next cases, changes in scintigraphy were studied utilizing various treatments.

Case 5. A 41-year-old female with classical rheumatoid arthritis, class 2, stage 4. With therapy of gold thiomalate the pain and swelling in both hands diminished. Scintigram before therapy was strongly positive in the wide region from radiocarpal joint to MP joints in both hands Scintigram in a maintenance therapy dose for 6 months after initial 1000mg of gold thiomalate showed markedly decreased radioactivity remaining only in intercarpal joint (Fig. 7).

Case 6. A 54-year-old female with definite rheumatoid arthritis, class 2, stage 2. The positive localization seen in the scintigram before gold thiomalate therapy corresponded to the pain and swelling areas. Scintigram at 1000 mg of gold showed excellent results. Scintigram in therapy of maintenance dose for 8 months after initial 1000mg of gold revealed recurrence of localization without complaints of pain and swelling (Fig. 8).

Case 7. A 52-year-old male with classical rheumatoid arthritis, class 2, stage 2, had complaints of pain and swelling which were relieved by injection of 5 mCi of

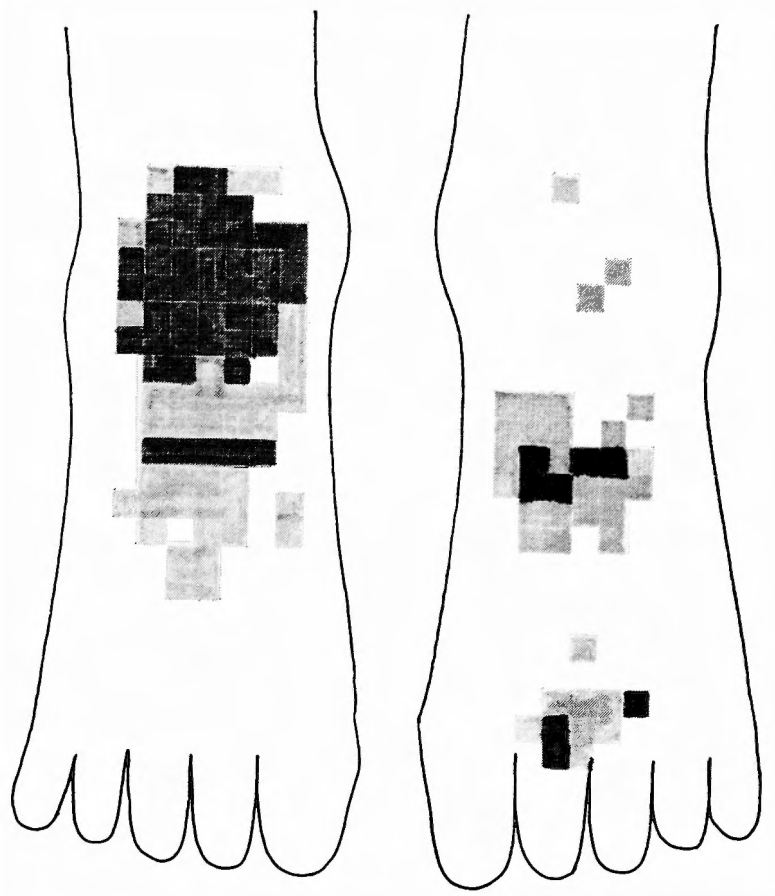


Fig. 6 Scintigram showed increasing radioactivity in talocrural, subtalar and Chopart joints of right foot and also in left Lisfranc joint and MP joint of 2nd and 3rd toes. (Case 4).

colloidal ^{198}Au in both wrist joints. Scintigram showed excellent effect of treatment reflected in even non-injected areas (Fig. 9).

Case 8. A 59-year-old female with classical rheumatoid arthritis, class 2, stage 3. The fingers of the left hand to the ulnar side. Synovectomy in both wrist joints and MP joints of each finger of the left hand with Swanson's silastic prosthesis in MP joints of index and middle fingers was performed. The hand deformity was satisfactorily corrected and the pain relieved. The patients complaints before and after surgery corresponded to scintigraphy (Figs. 10 and 11).

Discussion

Alarcon-Segovia and others[1] have reported that isotope scanning of joints using technetium showed a higher uptake by inflamed joints than by normal and degenerated joints. McCarty and others[4] have demonstrated a higher correlation between

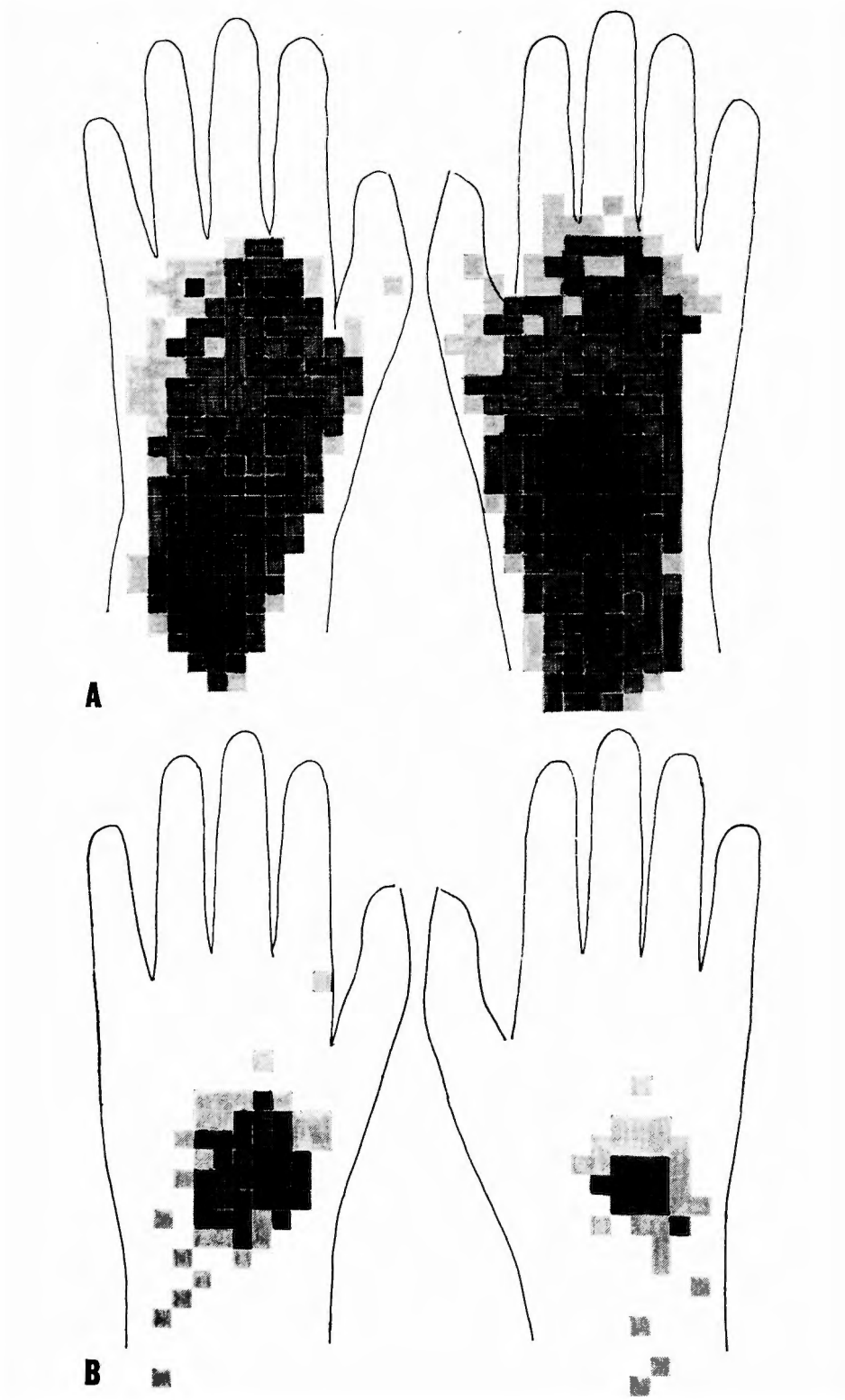
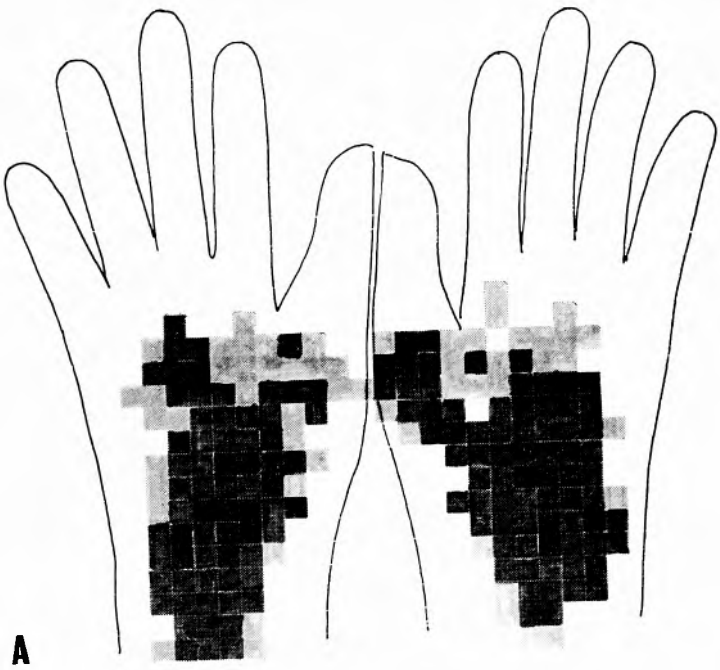
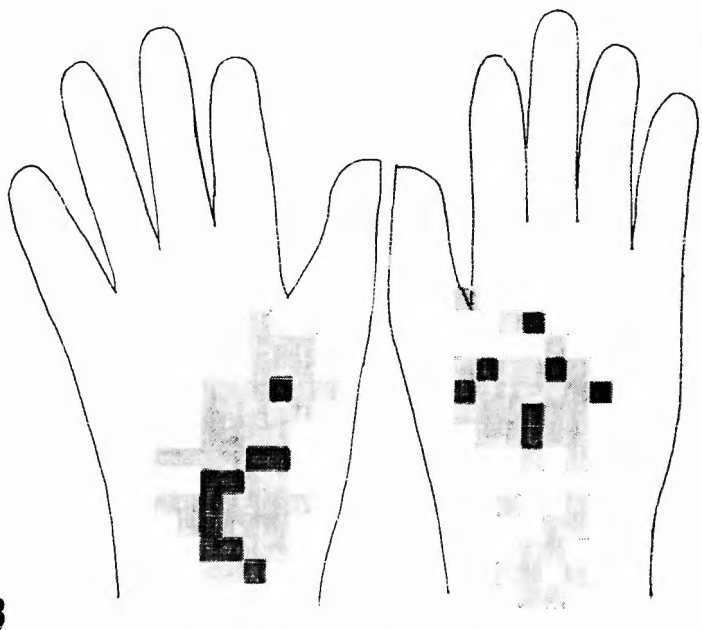


Fig. 7 A : Scintigram before gold therapy. B : Scintigram following gold therapy showed markedly decreased radioactivity remaining only in intercarpal joint. (Case 5).



A



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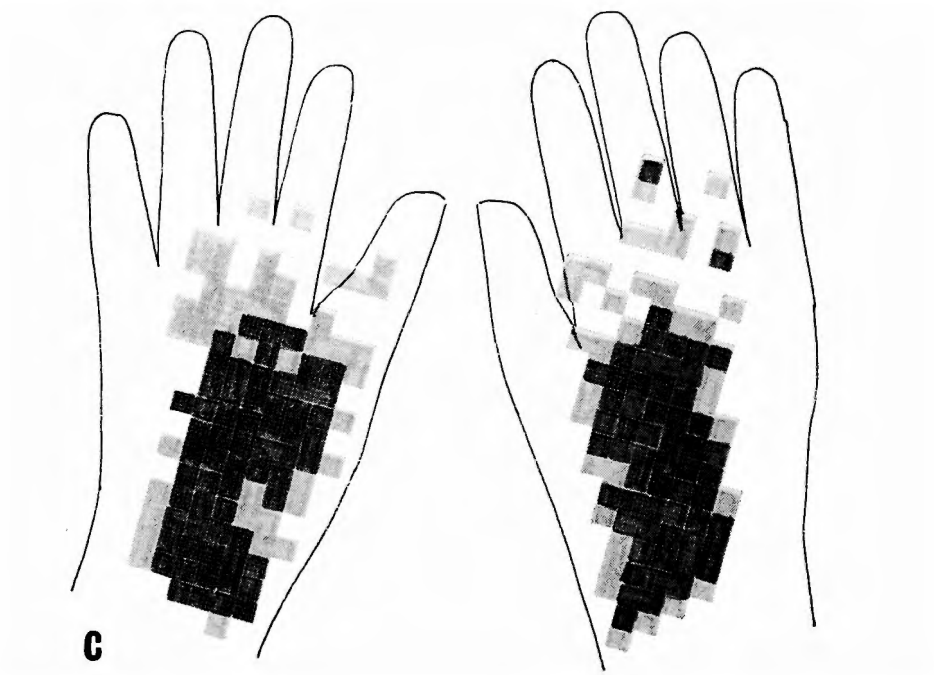

Fig. 8 A : Scintigram before gold therapy. B : Scintigram at 1000mg of gold therapy showed excellent results. C : Scintigram in therapy of maintenance dose for 8 months after initial 1000mg of gold revealed recurrence of localization. (Case 6).

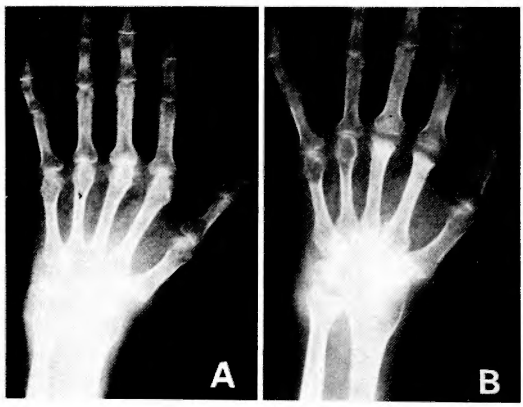

Fig. 10 Roentgenogram of right hand. A : Before surgery. Note ulnar deviation of fingers, narrowing of joint space of radiocarpal joint, and MP joint of index and middle fingers, as well as minor destructive changes of metacarpal head of index and middle fingers. B : After surgery. Synovectomy of wrist joint and MP joint of each finger with Swanson's silastic prosthesis replacement in MP joints of index and middle fingers was performed. (Case 8).

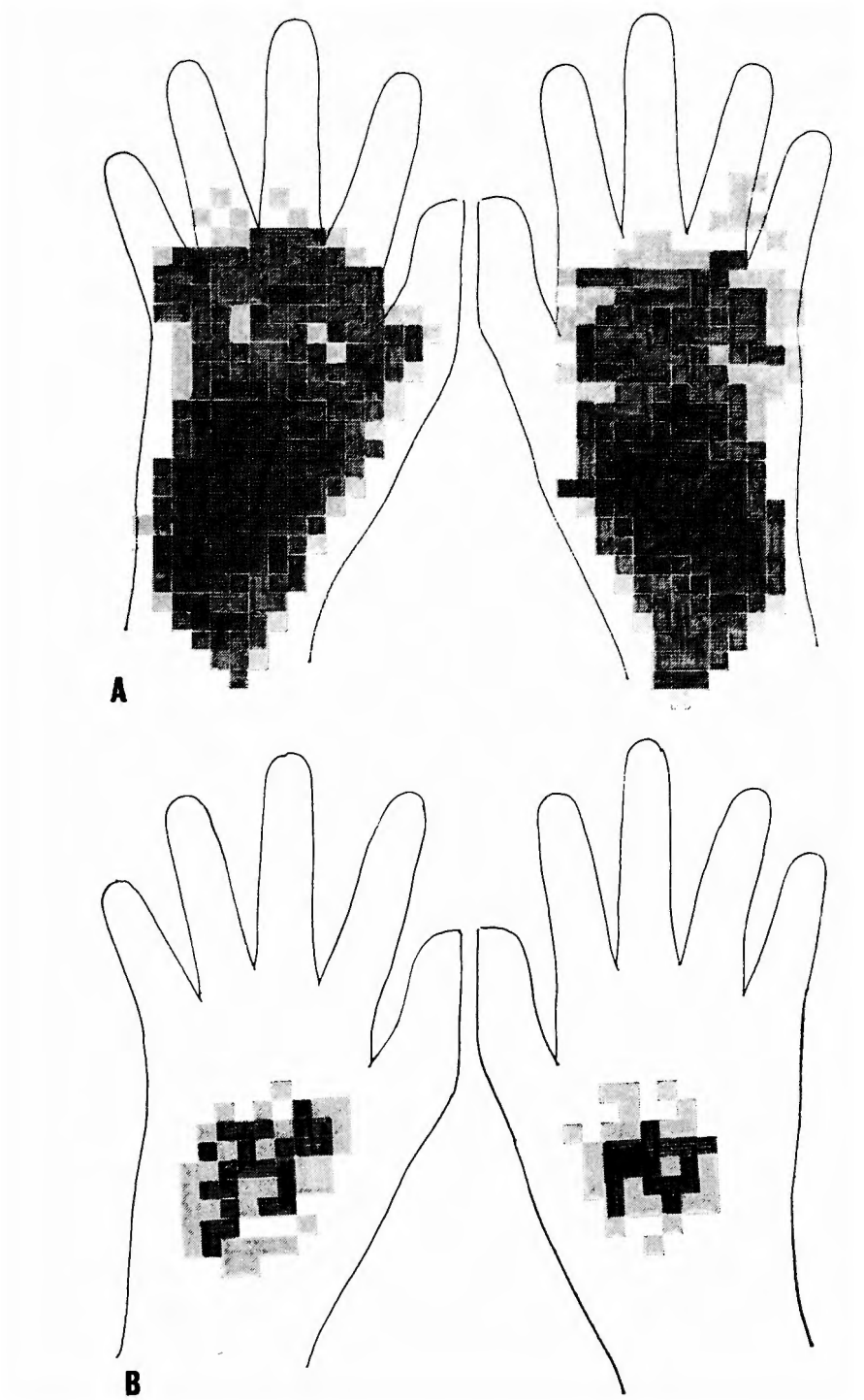

Fig. 9 A : Scintigram before radiation synovectomy. B : Scintigram of 6 months after injection of colloidal ^{198}Au into both radiocarpal joints showed excellent effects of treatment reflected in even non-injected areas (Case 7).

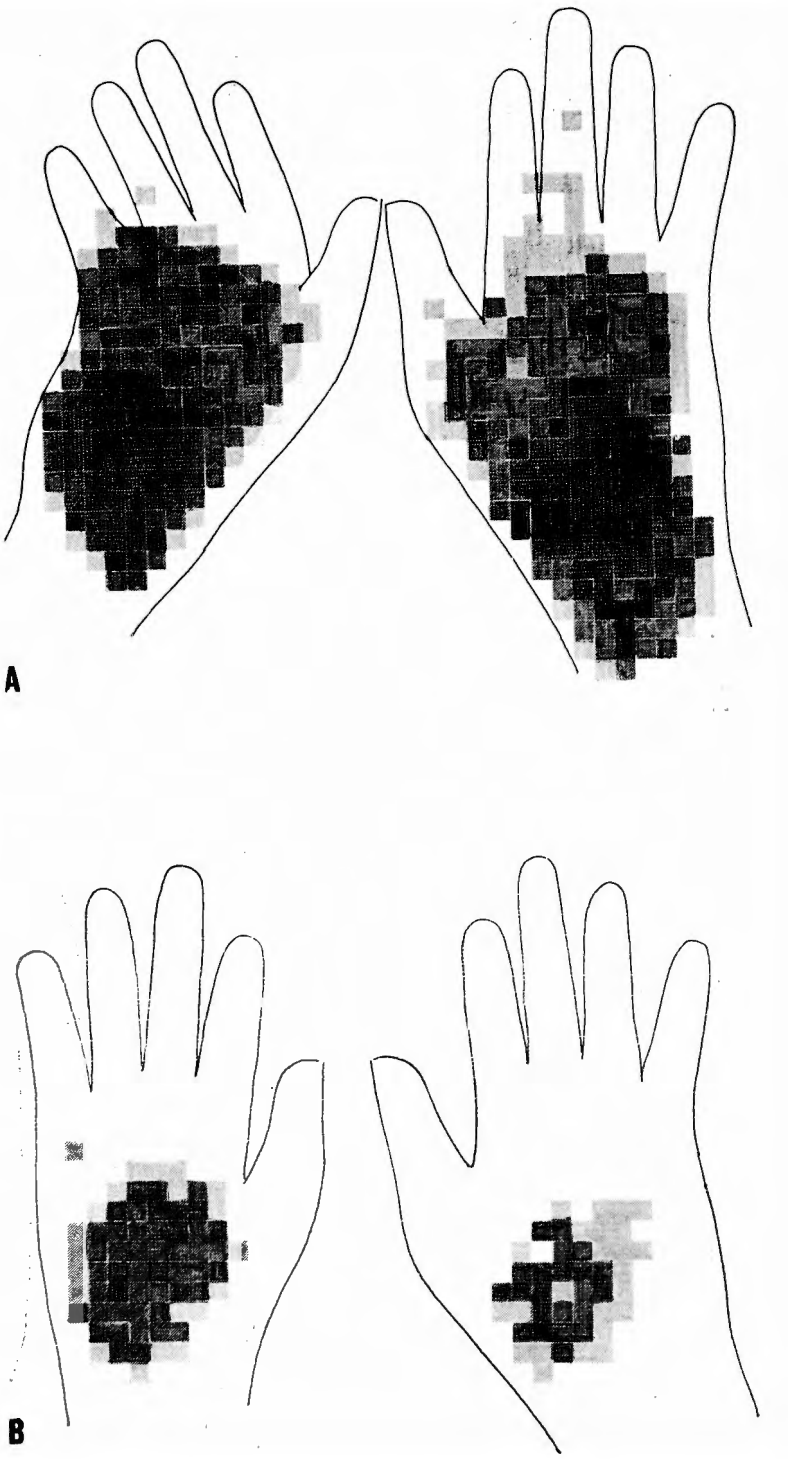

Fig. 11 Scintigram (A) before surgery with quite a different pattern from scintigram (B) after surgery, thereby demonstrating excellent results.

scintiphotography and clinical assessment, and mentioned that joint scanning appeared to be one of the most objective tests available for the evaluation of arthritis, particularly in acute stages. The hand has many joints, that is radiocarpal, intercarpal, carpometacarpal, MP, PIP and DIP joints. The foot has also talocrural, subtalar, Chopart, Lisfranc, MP, PIP and DIP joints. Joint scanning is more sensitive in detecting localization of affected areas in several joints than routine roentgenogram, as described by Maxfield and others[3]. Our study made it clear, however, that scintigraphy did not always correlate to clinical findings as there were several cases where uptake of isotope did not increase in affected joints with hydrops. These cases were found more in osteoarthritis in concomitance with hydrops than in rheumatoid arthritis. It is indicated that increasing uptake of radioisotope does reflect active inflammation but not always hydrops.

Changes were observed in the joint before and after treatments such as gold therapy, radiosynovectomy and surgery. As shown in Fig. 7, 8, 9 and 11, joint scintigraphy is a useful means for assessment of inflammation of joint as well as effects of treatment. There was a significant correlation (71%) between clinical findings and scintigraphy, however the sensibility of the latter proved more useful in diagnosis and treatment. It indicates that the scintigraphic method is more useful for patients having inflammatory joints were the x-ray findings or the CRP were negative.

It is considered that the increasing uptake of radioisotope by joints may be due to an increase in soft tissue and blood supply, plus joint effusion when present[1]. Maxfield and others[3] described that the localization is thought to be due to increased permeability of the synovial membrane rather than to increased vascularity. It is reported by Alarcon-Segovia and others[1], synovial fluid showed moderate radioactivity. As shown in Fig. 12, however, it was clarified that radioactivity in the joint did not decrease by aspiration of synovial fluid within 30 minutes after radioisotope injection and this fluid showed no increased activity.

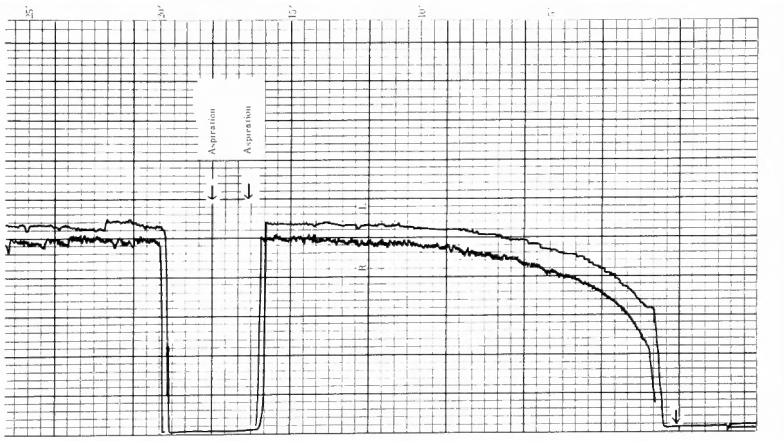

Fig. 12 Radioactivity in the joint area of both knees was unchanged after aspiration of joint fluid.

Conclusion

It was found that joint scintigraphy was a very useful method for assessment of localization and intensity of joint inflammation. Scintigraphy was also effective in evaluating therapy. Side effects have not been seen with scintigraphy.

Acknowledgements

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和文抄録

関節炎に対する関節シンチグラフィー

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浜本研

慢性関節リウマチを含む炎症性関節疾患45例に対して，炎症の局在，強さ及び治療による炎症の消長を客観的に判定することを目的として，放射性同位元素を用いて関節シンチグラフィーを行なった。

用いた核種は $^{99m}TcO_4^-$（半減期6時間）で，その5mCiを静注した。静注後同位元素は直ちに罹患関節に集積し，約30分で最高値に達した。この時点で直径11.5″，4000ホールのコリメータをもつシンチカメラで同位元素の分布状態を検出した。また同位元素の分布を1600チャネルのコアメモリーをもつ波高分析器により，X，Y軸の信号に変換してデジタル化し，この数値を段階に応じて色分けしてシンチグラムを作製した。関節の輪郭はシンチカメラでとったシンチ写真と対比して描いた。コントロールとして前腕中央部あるいは大腿中央部をとった。

手では radiocarpal joint, intercarpal joint, carpometacarpal joint, MP関節，PIP関節，DIP関節があり，足では talocrural joint, subtalar joint, Chopart joint, Lisfranc joint, MP関節，PIP関節，DIP関節と多数の関節があるが，関節シンチグラフィーにより罹患関節の部位と罹患の拡がり及び強さがわかる。慢性関節リウマチでは変形性関節症よりも同位元素は強く集積し，疼痛，腫脹，圧痛等の臨床所見と高い相関を示した。関節シンチグラフィーと臨床所見の一致率は71%であり，シンチグラフィーの方がより敏感である。次に時日を改めて検査することにより，シンチグラムの所見の推移から炎症の消長をみることが可能である。この際　注射量，$^{99m}TcO_4^-$静注後の測定時間を一定にしなければならない。治療として，金療法，^{198}Au や ^{90}Y による radiation synovectomy，手術療法等を行なった症例に対する関節シンチグラフィーから，この方法が炎症の消長をみるのに，また治療効果をみるのに優れていることを確かめた。

次に我々は膝で同位元素が関節に集積した後，関節穿刺を行ない滑液を排除したが，膝関節における同位元素の集積状態が静注後30分以内では変らず，また排除した滑液中にも放射能の上昇がみられないことを確かめた。

$^{99m}TcO_4^-$ による関節シンチグラフィーにより，副作用を来たした症例は認めなかった。